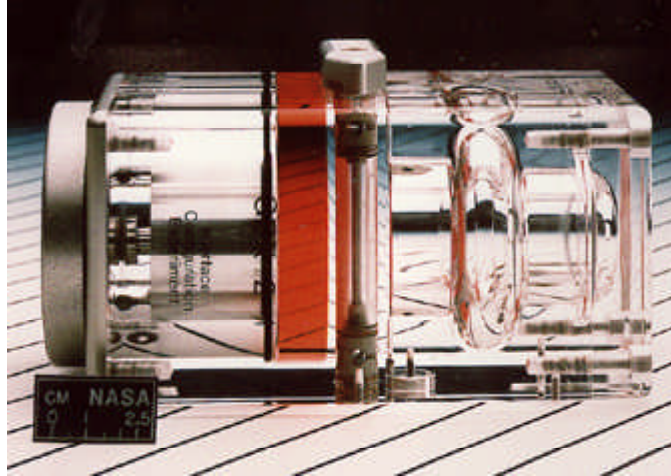


# Liquid-Vapor Interface Configurations Investigated in Low Gravity



*ICE vessel used on Mir.*

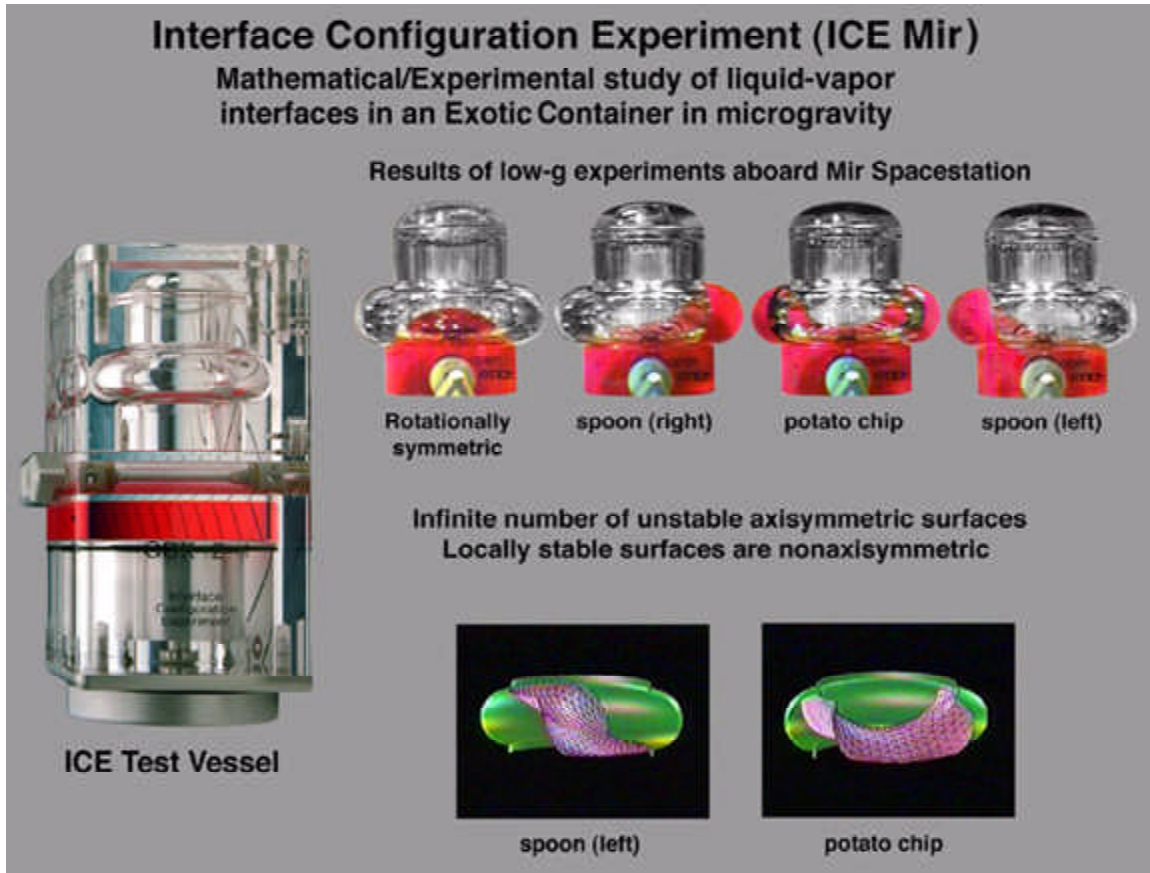
The Interface Configuration Experiment (ICE) is part of a multifaceted study that is exploring the often striking behavior of liquid-vapor interfaces in low-gravity environments. Although the experiment was posed largely as a test of current mathematical theory, applications of the results should be manifold.

In space almost every fluid system is affected, if not dominated, by capillarity (the effects of surface tension). As a result, knowledge of fluid interface behavior, in particular an equilibrium interface shape from which any analysis must begin, is fundamental--from the control of liquid fuels and oxygen in storage tanks to the design and development of in-space thermal systems, such as heat pipes and capillary pumped loops. ICE has increased, and should continue to increase, such knowledge as it probes the specific peculiarities of current theory upon which our present understanding rests.

Several versions of ICE have been conducted in the drop towers at the NASA Lewis Research Center, on the space shuttles during the first and second United States Microgravity Laboratory missions (USML-1 and USML-2), and most recently aboard the Russian Mir space station. These studies focused on interfacial problems concerning the existence, uniqueness, configuration, stability, and flow characteristics of liquid-vapor interfaces. Results to date have clearly demonstrated the value of the present theory and the extent to which it can predict the behavior of capillary systems.

For example, on Mir the experiments conducted by crew member Shannon Lucid revealed that multiple, locally stable interface shapes are indeed possible in a single rotationally symmetric container. What is striking about these capillary surface configurations is that some of them are not rotationally symmetric. Though such configurations have been predicted mathematically and numerically, the concept of asymmetric surfaces in symmetric containers is startling, particularly when such surfaces can possess differing characteristics, such as natural frequency, damping, and stability. At present there is no

method to predict how many locally stable interfaces a given container might yield, even for the relatively simple geometry of ICE aboard Mir. Nonetheless, such results communicate clearly that designers of in-space fluids systems should be aware of, if not account for or exploit, such possibilities in fluids management processes.



*Interfaces observed during Mir space station ICE experiments and numerical predictions. Top, left to right: observed symmetric, spoon right, potato chip, and spoon left configurations. Bottom, left to right: computed spoon left and potato chip configurations.*

These experiments were conceived and developed by Paul Concus of the Lawrence Berkeley Laboratory and the University of California at Berkeley, Robert Finn of Stanford University, and Mark Weislogel of the NASA Lewis Research Center. The experiment hardware was designed and built at Lewis.

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